Incomplete fusion dynamics in $^{19}F + ^{154}Sm$ system@110MeV

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Introduction

In the study of incomplete fusion dynamics the production of fast projectile-like fragments (PLFs) has been a topic of growing interest at projectile energies near and/ above the Coulomb barrier. Enough evidences are available in the literature to believe that complete fusion (CF) and incomplete fusion (ICF) are the only dominant reaction modes at projectile energies below 8 MeV/nucleon. Britt and Quinton [1] has been first investigated the production of fast PLFs in ICF dynamics in their pioneering measurements. However, recognition of this process referred to as 'ICF' was received after the charged particle-γ-coincidence measurements by Inamura et al. [2]. Semi-classical theory of heavy ion (HI) collision categorize in two processes CF and ICF on the basis of driving input angular momentum imparted in the interacting partners. In CF process the projectile completely fuses with the target nucleus and form a highly excited compound nucleus, which decays by evaporating low energy nucleons and α-particles. In ICF process, only a part of projectile fuses with the target nucleus, while remnant moves in the forward direction [3-4]. The excited composite system formed as a result of the fusion of the fragment of incident ion beam with the target may also under go de-excitation by emission of particles and / or γ-rays. Many experimental studies have been carried by using alpha cluster structure projectile with different targets, but none of these available by using non alpha cluster structure projectile. However, ICF dynamics studies by using non alpha cluster structure projectiles are still demanded. To the best of our knowledge these measurements have been reported for the first time.

Experimental Details

The present charged particle-γ coincidence experiment for the system $^{19}F + ^{154}Sm$ @110 MeV has been performed at Inter University Accelerator (IUAC), New Delhi, India. In order to record particle-γ coincidences, Gamma Detector Array (GDA) along with Charged Particle Detector Array (CPDA) set up has been used. A self-supporting target of ^{154}Sm (enrichment ≈98.69%) of thickness ≈3.1 mg/cm^2 was prepared by rolling machine. The GDA is an assembly of 12 Compton suppressed high purity germanium γ-spectrometers at angles 45^0, 99^0, 153^0 with respect to the beam direction and there are 4 HPGe detectors at each of these angles. The CPDA is a set of 14 Phoswich detectors. In the CPDA scattering chamber, seven CPD were placed on top and seven on bottom of the chamber. All 14 detectors of CPDA have been divided into three angular zones;.(i) Forward angles (F) 10^0-60^0 (ii) Backward angles (B) 120^0-170^0 and (iii) sideways (S) 60^0-120^0. In the present experiment two groups of α-particles are expected to be detected by forward angles (F) CPDs: (i) the fusion-evaporation (CF) α-particles of average energy Eα-CF≈17.7 MeV and (ii) the ICF 'fast' α-particles of energy Eα-ICF≈27.5 MeV. In front of the each four forward cone CPDs, aluminum absorbers of appropriate thickness have been used to stop 'evaporation' α-particles (Eα-CF≈17.7 MeV). Hence, only 'fast' α-particles' with energy greater than 17.7 MeV have been detected in the forward cone. The no. of events plotted as a function of evaporation α-

particle energy for forward cone (10^0-60^0) in the ^{19}F + ^{154}Sm system predicted by PACE4 at projectile energy110 MeV is shown in Fig.1. It can be seen from Fig.1 a single peak corresponds to the evaporation (CF) α-particles of average energy Eα-CF≈17.7 MeV.

Analysis and Results

The preliminary data analysis has been done during the experiment by using software's CANDLE and INGASORT. The observed Gamma ray energy spectrum for ^{19}F + ^{154}Sm system at 110MeV is shown in Fig.2.

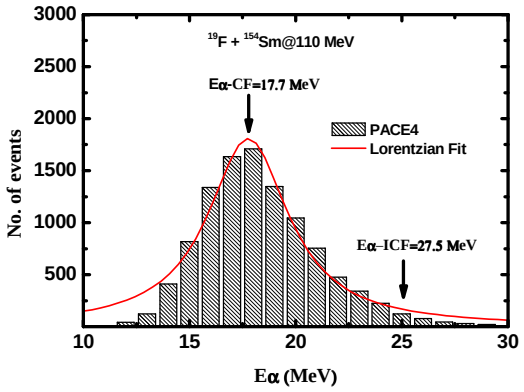

Fig. 1 Evaporation α-particle energy profile for forward cone (10^0-60^0) in the ^{19}F + ^{154}Sm system predicted by PACE4 at projectile energy 110 MeV.

The four evaporation residues (ERs) ^{168}Lu(5n), ^{167}Lu (6n), ^{166}Tm(α3n) and ^{165}Tm (α4n) has been indentified from the gamma rays spectra. The evaporation residues (ERs) ^{168}Lu and ^{167}Lu will produce through CF of ^{19}F with ^{154}Sm by the emission of 5 and 6 neutrons from the compound nucleus, respectively. The evaporation residues ^{166}Tm produced though the emission of one α and 3 neutrons, while ^{165}Tm produced though the emission of one α and 4 neutrons. These ERs may be populated through the ICF process.

The analysis of the data is still in progress. The detailed information regarding the results will be presented in DAE-Symposium.

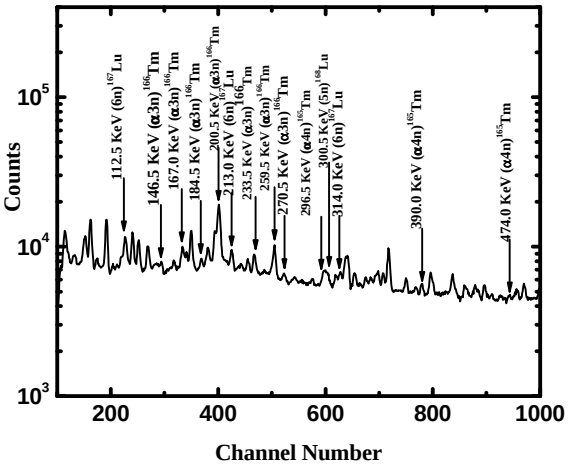

Fig. 2 Gamma ray energy spectra observed from ^{19}F + ^{154}Sm system at 110MeV

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